Lebanese University
Faculty of Science
BS Computer Science
2nd Year – S3

I2204 - Imperative Programming

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Linked Lists Exercises

Chapter 4

Linked List Exercises

1. Linked List of Contacts
2. Linked List of Integers
3. Linked List of Students
4. Linked List of Bank Accounts
5. Polynomials: Linked List of Terms
6. Doubly Linked List
7. AMSTRAMGRAM: Circular Linked List

Exercise: type contact

- contact type is defined to manage **sorted** linked list of contacts
- data stored concerns
  - name
  - tel (int)
- define the data type contact

Exercise: Push contact

- write the **Push** function which pushes a new node to the head of a contact list
  - (push does not care of the order)
  - the function type must be void

Exercise: printContact

- write the function printContact which prints a given contact

Exercise: printContacts

- write the function printContacts() that prints out the content of a given contact list, a contact per line
  - iterative version
  - recursive version

Exercise: deleteContact

- write the function deleteContact() that given a list of contacts, and a name, deletes the contact holding that name from the list
  - only first iteration
  - all of them

  - using localRef or not
  - iterative version
  - recursive version

Exercise: deleteList

- write the function deleteList() that takes a list of contacts, deallocates all of its memory and sets its head pointer to NULL (the empty list)

Exercise: insert

- write the function **insert()** that inserts a given name and tel number in a given list
  - in the right place → remember they are sorted
  - iterative version
  - recursive version
- hint : think of using the Push function, with the appropriate parameters

Exercise: numberOf

- write a function numberOf() that returns the telephone number of a given name
  - of the first occurrence

Exercise: displayAll

- write a **recursive** function displayAll() that displays all the contacts having a given name

Exercise: occurrence

- write the function occurrence() that returns the number of times a given name occurs in a given list
  - iterative version
  - recursive version

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Important

- In the following, we will use the following declaration:

```
typedef struct node{
  int data;
  struct node* next;
} node;
```

Exercise: count

```
typedef struct node{int data; struct node* next;} node;
```

- write the function count (iterative & recursive)
  - returns the number of nodes in a list

```
void countTest(){
      node* head=buildList();
      printf("%d", count(head));          //7
}
```

Exercise: printList

```
typedef struct node{int data; struct node* next;} node;
```

- write the function printList (iterative & recursive)
  - prints on the screen the values in data field of nodes

- example

```
void printListTest(){
    node* head=buildList();
    printList(head);          // 1,3,5,6,3,8,9
}
```

Exercise: printRList

- Write a function named printRList that prints the list elements in reverse order.

```
void printRList Test(){
      node* head=buildList();
      printRList(head);       // 9,8,3,6,5,3,1
}
```

Exercise: averageList

- Write a function named averageList that prints the average of nodes in the list.

```
void averageListTest(){
      node* head=buildList();
       printf("%lf",averageList(head));   // 5.0
}
```

Exercise: isSortedList

- Write a function named isSortedList that checks whether the nodes in a list are sorted in ascending order.

```
void isSortedListTest(){
      node* head=buildList(),*head2=buildListSorted();
      printf("%d",isSortedList(head));    // 0
      printf("%d",isSortedList(head2));   // 1
}
```

Exercise: incList

- Write a function named incList that adds a number passed as a parameter to each element of a given list.

```
void incListTest(){
      node* head=buildList();
      addNumberToList(head,2);
      printList(head);        // 3,5,7,8,5,10,11
}
```

Exercise: isRepeatedInList

- Write a function named “isRepeatedInList ” that checks whether a number is repeated in the list.

```
void isRepeatedInListTest(){
	node* head=buildList();
	printf("%d", isRepeatedInList(head,3)); // 1
	printf("%d", isRepeatedInList(head,8)); // 0
	printf("%d", isRepeatedInList(head,4)); // 0
}
```

Exercise: swapInList

- Write a function named “swapInList ” that swaps the contents of 2 nodes (of index `i` and `j`) in the list

```
void swapInListTest(){
	node* head = buildList();
	 swapInList(&head,1,3);	// swaping 3 by 6
	printList(head);	// 1,6,5,3,3,8,9
}
```

Exercise: removeFromList

- Write the function removeFromList which removes from a given list, the nodes having the given value.
  - iterative
  - recursive

```
void removeFromListTest(){
  node* head=build123();
  removeFromList(&head,1);
  printList(head);
 }
```

Exercise: insertNthList

- Write the function insertNthList which inserts in a given list, a given value, at a given index.
  - iterative
  - recursive

```
void insertNthListTest(){
  node* head=build123();
  insertNthList(&head,1, 2);
  printList(head);
 }
```

Exercise: PushToEnd

- Write the function insertNthList which inserts in a given list, a given value, at a given index.
  - iterative
  - recursive

```
void PushToEndTest(){
  node* head=build123();
  PushToEnd(&head,4);
  printList(head);
 }
```

List Application

- Write a complete Linked List Application with a menu.
- in a while(1) loop calls
  - menu() → see next slide
  - scanf()
    - if 0 exit from loop
    - if nb between 1 and 8
      - call the “call” function → see next slides

- function to print menu:
  - Enter your choice,
  - 1- create a empty list of integers
  - 2- display your list
  - 3- add one node to the head of your list
  - 4- add one node to the tail of your list
  - 5- delete one node containing the value v
  - 6- delete all the nodes containing the value v
  - 7- free the list
  - 8- insert a value at given index (insertNth)
  - Etc

Example to a call function

- suppose the user enters the choice 8
- insert a value at given index
- the function insertCall() will be called:
- void insertCall(node ** headRef){

```
    int value, index;
    //read v from keyboard..
   printf("please enter the value and the index");
   scanf ("%d %d", &value, &index);
   //call add to insertNth
   insertNth (headRef, index, value);
}
```

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Exercise: major

```
typedef struct Student{char name[20]; int id, grades[6];}std;
typedef struct node{std data; struct node* next;}node;
```

- write a function major which
  - given a list of students in a class
  - return a pointer to the major of the class
  - the major is the student with highest average

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Exercise: transfer

```
typedef struct node{
     char name[20];
     int id;
     double balance;
     struct node* next;
}node;
```

- write a function transfer which
  - given a list of bank accounts, and
  - two account number, and
  - an amount
  - transfers the given amount fro the balance of the sender (id=from) to the receiver (id=to)

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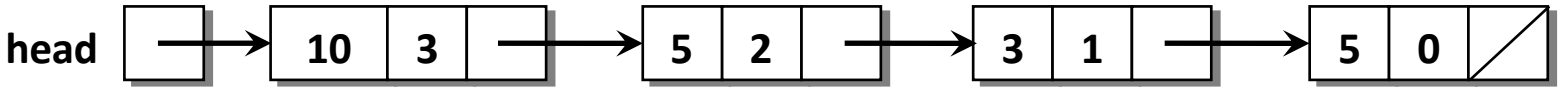
Polynomial

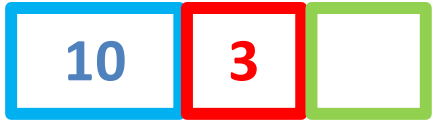
- we use linked lists to represent polynomials
- each node in the list corresponds to a term $\mathbf{c}x^{e}$, with its coefficient c and its exponent e

$$\mathbf{10}x^{3} + \mathbf{5}x^{2} + \mathbf{3}x + \mathbf{5}$$



Exercise: term

- define the data type **term** containing the following fields
  - **coef**
  - **exp**
  - **next**



Exercise: PushTerm

- write the function Push()
  - that creates and adds a new term to the head of a given list, term data are given as arguments
  - this is the classic void Push we studied in the course that takes double pointer (headRef)
- write PushTest()
  - construct the polynomial $10x^3 + 5x^2 + 3x + 5$
  - hint : put all the coefs in an array and all the corresponding exps in another array both of size 4, then loop and Push one node at a time

Exercise: printPolynomial

- write the **recursive** function **printPolynomial()**
  - that prints a given polynomial on the screen
  - example : $[10x^3 + 5x^2 + 3x + 5]$
- write **printPolynomialTest()**

Exercise: addPolynomials

- write the function **addPolynomials()**
  - that sums 2 given polynomials and returns the result
  - the result will be a 3rd polynomial allocated in heap
- write the function **addPolynomialsTest()**
  - create 2 polynomials (recall PushTest)
  - print them
  - add them
  - print the resulting polynomial

$$[10x^3 + 5x^2 + 3x + 5] + [3x^3 - 7x^2 + 3x - 6] = [13x^3 - 2x^2 + 6x - 1]$$

Exercise: addPolynomials2

- For advanced students
- Repeat the lab taking into account terms having zero coefficients $0x^6$
- Zero coefficient terms must not be present (allocated)

$$10x^7 + 5x^4 + 3x^2 + 5$$

- Rethink the **addPolynomials2()**
  - the sum of 2 terms of nonzero coefficients may lead to zero; $5x^2 - 5x^2 = 0$
  - there may be nonzero terms in first polynomial and zero terms in the second and vice-versa;

$[10x^7 + 5x^4 + 3x^2 + 5\ ] + [3x^8 + 3x^4 + 3x - 6] = [3x^8 + 10x^7 + 8x^4 + 3x^2 + 3x - 1]$

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Doubly Linked Lists

- Consider the following data type:

```
typedef struct node{
    int d;
    struct node *next, *prev;
} node;
```

Exercise: reverse

- Write a function "reverse" which reverses the order of the nodes in a given doubly linked list of integers.
- For example,
  - the list
    - [3⇌9 ⇌5⇌1]
  - becomes after the call to reverse
    - [1⇌ 5⇌ 9⇌ 3]

Exercise: merge

- Write a function "merge" which
  - merges two sorted doubly linked lists of integers into one.
  - The merged list must remain sorted.
  - No Node allocation or deletion is allowed.
  - Only one iteration is allowed for each list.
  - The function must return the head of the resulting merged list.

Exercise: clean

- Write the function "clean" which,
  - given a doubly linked list of integers, not sorted,
  - finds and deletes all the duplicates from the list.
- For example,
  - the list
    - [1⇌ 5 ⇌ 9⇌ 5⇌ 1⇌ 3⇌ 3⇌ 1⇌ 1]
  - becomes after the call to clean
    - [1⇌ 5⇌ 9⇌ 3].

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AM-STRAM-GRAM

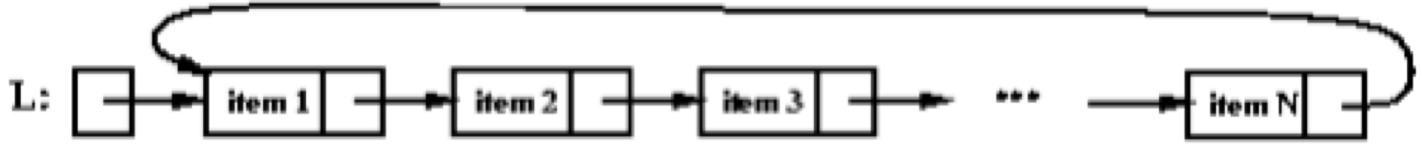
- To play the AM-STRAM-GRAM game,
  - N children form a circle,
  - choose a child to be the first,
  - start counting from this child till the k^{th} child who leaves the circle,
  - then we continue counting from current child till the next k^{th} child who will leave the circle ,
  - and so on until no child is left in the circle.

Exercise: struct child

- We suppose that a child is represented by an integer number
- Define the adequate data structure

list of children

- We represent the circle of children by a circular list



  - the last node points to the first one instead of pointing to NULL
- so to iterate down the list
  - the condition while(current!=NULL) is not valide anymore!!!
  - what is the new condition??

Exercise: play

- Write a function that displays the set of children in the order of their removal from the circle.
- Each time a child must leave the circle,
  - its node must be freed and
  - the linking must be maintained
    - the node before must points to the node after
    - unless we remove the last node in list
    - pay attention when you remove the first node (head value changes)
- The function inputs are
  - the list
  - the number k
- Example: for k = 3 and the following list :

Example: for k = 3 and the following list

1	2	3	4	5	6

Exit of 3

1	2	**4**	5	6

Exit of 6

1	2	4	5

Exit of 4

1	2	**5**

Exit of 2

1	**5**

Exit of 5

1

Exit of 1

We mark the current element in **bold**. Thus the result is: 3, 6, 4, 2, 5, 1.